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# INDUSTRY PRACTICE

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## COLLABORATION OF GLASS ENTERPRISES WITH REFRACTORIES PRODUCER 'DINUR' JSC

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The problems of cold and hot maintenance work on glassmaking furnaces at glass enterprises are presented. 'DINUR' JSC offers assistance and joint collaboration with glassmaking enterprises. New refractory articles, including the DSU-1 glass-dinas brand, which makes it possible to increase furnace life, are proposed. The characteristics of other refractory materials that can be used in different structural units of a glassmaking furnace (roofs, regenerators, suspended walls, doghouse arches and burner blocks) are examined in detail.

***Key words:*** refractory materials and articles, glass-dinas articles, glassmaking furnace.

Glass production is undergoing complex changes pertaining to the distribution and shape of the markets. These problems are reflected in the financial wellbeing of enterprises. The conservation of financial resources at each enterprise must be rational and justified. The specialists in glassmaking enterprises must follow commodity prices and quality closely. This also pertains to refractory products for cold and hot repairs of glassmaking furnaces. The tendency to use only imported refractories is not dogma. Engineers directly involved in repair work and the operation of furnaces know that domestic refractories are at least as good as the foreign analogs and in individual cases can surpass the latter in terms of stability, and the prices of the domestic products are more attractive.

It is especially important to pay attention to the technical characteristics of refractories in order to make a rational choice of the complete set of equipment units for a furnace. Analysis of the refractories used in furnaces at different enterprises has shown that because of the choice of brand and producer of the refractory (especially a refractory manufacture abroad) the specialists at glass plants must expend a great deal of effort and means on maintaining a furnace using hot repairs in the working state during the entire furnace run, and often the actual service life of a furnace is shorter than the nominal life. For example, when a furnace is stopped because of the wear of its tweel the state of the main roof is found to be satisfactory.

Practically all sheet glass producers use foreign made glass-dinas rather than the Russian product ('DINUR' JSC) in the furnace tank. In addition, it is acknowledged that the quality of the glass-dinas produced by 'DINUR' meets the generally accepted specifications, which has been proved by many years of use. The unique characteristics of quartzites from Karaul'naya mountain, which are used in the production of glass-dinas, together with the reconsidered fabrication recipe and the firing schedules have improved the technical performance and quality of the articles produced.

Glass container enterprises (our regular customers) confidently purchase glass-dinas. There are no complaints. In addition, its service life has increased (the wear of the refractories is only 5 – 10% compared with other articles of all structural elements of the furnace). It should be noted that the service life of the furnaces used in glass container enterprises is shorter than that of the tank furnaces used in sheet-glass production. As a result it is now believed that the glass-dinas produced by 'DINUR' JSC will not last for the entire furnace life at enterprises producing sheet glass, which is absolutely untrue. Glass-dinas produced by 'DINUR' JSC has lasted on the main arch of the doghouse in the furnace at 'Saratostroisteklo' for more than 10 years without any complaints. Unfortunately, this fact is not generally known.

An important phase of putting a glassmaking furnace into operation is the initial firing of the furnace. For this rea-

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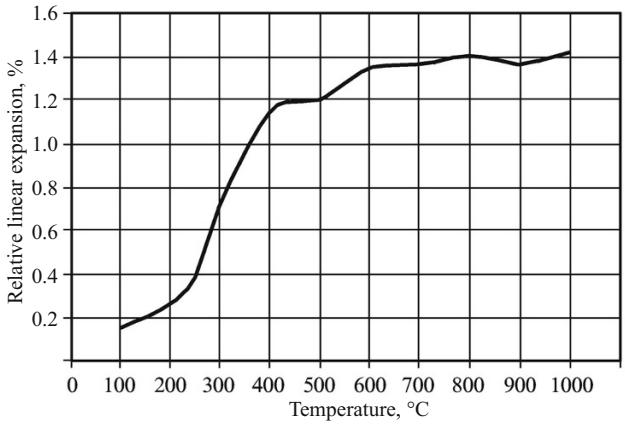


**Fig. 1.** The relative linear expansion of the DSU-1 refractory.

son our specialists investigate the relative specific expansion (shrinkage) of each new article. For example, the new brand of glass-dinas articles DSU-1, which is now being used in the main roofs of glassmaking furnaces at 'Svet' JSC (Mozhga) and 'Simvol' JSC (Kurlovo) showed a significant difference in the relative linear expansion from the traditional brands DSO and DS. As one can see from the schedule of the relative linear expansion of the DSU-1 refractory (see Fig. 1), because the amount of residual quartz in the refractory is minimal the main roof grows very little at temperatures 120 – 180°C compared with the DS and DSO articles. Analysis of the actual graphs of the initial firing-up of the furnace showed that the optimal temperature rise rate is 2.5°C/h. This will help to avoid sharp changes in the 'growth' of the main roof during the entire initial heating period and additional soaking at one temperature after a sharp jump.

At the present time new refractory materials, which have successfully proven themselves in the metallurgical industry, have been developed and are now being produced. Much of the development work was performed in collaboration with customers. The practice acceptable to both enterprises should also used in glass enterprises.

Recently, glass producers have raised questions concerning the repair work volume and articles for hot repairs. Such articles can be made of quartz glass. The use of GSBF brand articles (Table 1) is justified by their unique operating characteristics. These articles has high thermal resistance (up to 1150°C), ultimate strength in compression at least 25 – 31 $N/mm^2$, linear thermal expansion coefficient (CLTE) $0.56 \times 10^{-6} K^{-1}$ in the temperature interval 20 – 1000°C and thermal conductivity 1.0 $W/(m \cdot K)$ at temperature 800°C.

Articles are produced from quartz glass by different methods: centrifugal casting, casting in a gypsum mold, electrophoretic molding and semi-dry pressing. The choice of molding is determined by an article's configuration and dimensions.

At present KSBF articles are placed in a glassmaking furnace at 'PILKINGTON GLASS' JSC in order to secure the top of the tweel. Specially prepared MDK dinas mortar (taking account of the customer's requirements) was used as the binder; it showed better adhesion to the hot wall of the tweel of the glass melting tank than the imported mortar.

The KSBF articles were also placed in the doghouse arch in the glassmaking furnace at 'Gomel'steklo' JSC.

According to the latest inquiries, 'PILKINGTON GLASS' JSC and 'Gomel'steklo' reported on the good performance of KSBF refractories and it was noted that there were no adverse effects on glass quality.

Modern technologies for producing articles and high-silica aluminum-silicate batches are used as 'DINUR' JSC. MLV concrete mixes and MLVB articles (Table 2) can be used for the brickwork of the doghouse arch and for fabricating burner stones. Mullite vibro-poured concrete mixes and articles are produced using a hydraulic binder — cement pro-

**TABLE 1.** Characteristics of KSBF Articles

| Index | TT 202-109–2012 norm | Actual |
|---|---|---|
| Mass fraction, %: | | |
| $SiO_2$, at least | 98.0 | 99.20 |
| $Fe_2O_3$, at most | 0.2 | 0.07 – 0.10 |
| Open porosity, %, at most | 20 | 12 – 14 |
| Ultimate strength in compression, $N/mm^2$, at least | – | 25 – 31 |
| CLTE at 20 – 100°C, $K^{-1}$ | – | $0.56 \times 10^{-6}$ |
| Thermal conductivity at 800°C, $W/(m \cdot K)$ | – | 1.0 |

**TABLE 2.** Characteristics of MLVB and MKRV-12FP Articles

| Index | MLVB TU 1568-053-00187085–2007 | MKRV-12FP TU 1567-058-00187085–2008 |
|---|---|---|
| Mass fraction, %: | | |
| $Al_2O_3$ | 65.0 – 76.0 | 57.0 |
| $Fe_2O_3$, at most | 1.3 | 1.2 |
| $SiO_2$, at most | 30.0 | 39.0 |
| CaO, at most | 2.0 | 2.0 |
| Open porosity, %, at least | 19.0 | 15.0 |
| Ultimate strength in compression, $N/mm^2$, at least | 70 | 70 |
| Additional linear growth at 1550°C, at most, % | 0.4 | – |
| Softening temperature, at least, °C | 1630 | 1640 |
| Heat resistance,* thermal cycling, at least | 15 | – |

* The heat resistance of articles is determined according to GOST 7875.1–94, in which the procedures prescribe testing of articles under more stringent conditions than in European procedures.

duced in Europe. Aluminum-silicate mineral — African andulasite — is used as the filler.

Andulasite is a pure aluminum silicate $Al_2O_3 \cdot SiO_2$, which theoretically contains 63% $Al_2O_3$ and 37% $SiO_2$ and together with kyanite belongs to the sillimanite group, is distinguished by higher purity compared with other refractory raw materials, specifically, bauxite and chamotte.

Andulasite has a number of advantages for use in refractory industry, mainly owing to its capability of forming at low temperature a crystalline phase of mullite (mullitization process) with high hardness up to high temperatures. Firing transforms andulasite-based refractories into completely new materials based on primary mullite, secondary mullite and a small amount of high-viscosity glass phase. This combination of components imparts to refractories new properties which are not comparable to other types of alumina refractories. The refractories obtained using andulasite give the following as a result of their unique structure:

– constancy of volume;
– high heat resistance;
– very high refractoriness (due to low content and high viscosity of the liquid phase) under a load;
– resistance to creep at high temperatures;
– good resistance to chemical action of CO (as a result of low iron content), alkali and slags (due to low porosity and high viscosity of the quartz glass);
– enhanced mechanical properties at high temperatures;
– low thermal conductivity.

An experimental sample of an MLVB burner stone, placed in the entrance of the glassmaking furnace at 'Svet' JSC (Mozhga) near the hotspot, showed good performance without any claims. As a result a batch of burner stones for all entrances of the glassmaking furnace was ordered.

Concrete mullite-silica vibro-poured concrete mixtures of the type MKRV-12 and articles of the type MKRV-12FP (Table 2), developed at the same time as MLV concrete and MLVB articles but for use in metallurgical production, also possess all the properties listed above. A small volume increase due to mullitization makes it possible to compensate for the presence of cracks in concretes. The MKRV-12 concrete mixture can be used to pour rider blocks.

The recommendations made for using refractories help the manufacturers of glass products to organize incident-free operation of heating units. The diverse assortment of products produced at 'DINUR' JSC can be found at its site http://www.dinur.ru. Our specialists are always ready to collaborate: tel. 8 (3439) 278-617.